The Stanford Health Information Network for Education: Integrated Information for Decision Making and Learning

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Although multiple decision support systems have been built for physicians, efficient delivery of valid and complete medical knowledge remains an elusive goal. In this paper we describe a new project, the Stanford Health Information Network for Education (SHINE). SHINE unifies core medical resources in an intuitive interface to support clinical decision making. Included in the description is a novel paradigm for continuing medical education (CME).

INTRODUCTION

Keeping pace with the rapid expansion of medical knowledge and applying it accurately in clinical practice are impossible using traditional information resources. This has led to several recent studies which highlight the unmet information needs of physicians[1-3]. The inability to retrieve valid and relevant information easily may account for the serious gap between the knowledge physicians use in practice and what is known to medical science[4]. In a recent local survey, the textbooks available in physicians' offices were often greater than ten years old and quick access to current information was frequently limited to chance encounters with colleagues in the hallway[5].

Many medical reference databases and expert systems have been built to improve access to information and to support clinical decision making. These resources include MEDLINE, electronic textbooks and journals, specialized text and image databases, and various diagnostic and therapeutic support systems. While all facilitate access to medical knowledge, several factors limit their wide-spread use and acceptance. Practitioners are often unfamiliar with the structure and organization of these resources, and most do not have sophisticated information retrieval skills. The Internet offers many advantages as an information delivery system, and the number of Web sites providing medical knowledge is expanding rapidly. Still, much of the information found on the Internet is poorly organized, of variable authority, difficult to locate, and not integrated with other clinical data. Thus, despite the availability of high quality content, contemporary information management methods still do not allow physicians to answer clinical questions efficiently and confidently.

SHINE was developed with the hypothesis that an integrated collection of core content and a simple, unified query and results interface will permit rapid, focused responses to physicians' questions for both immediate decision making and in-depth education. In this paper we describe the SHINE system and our approach to improving knowledge delivery. We also report our early attempt to assess clinical questions and the ability to answer them with current information resources.

PRELIMINARY DATA

The motivation for SHINE was fueled by a survey of approximately 250 local primary care physicians to gage potential interest in online CME. The survey also assessed their preferences for topics to be covered by a theoretical knowledge delivery system. They were asked to list unanswered medical knowledge questions generated in daily practice that they felt would impact their decision making. Approximately eighty-five percent of the physicians responded with a total of about

1091—8280/97/$5.00

300 questions, and most practitioners indicated that they were interested in online education. Similar and redundant questions were grouped to form a list of eighty distinct questions. These questions were submitted to a review committee composed of five academic general internists who ranked the questions in terms of clinical importance and frequency. The questions from this survey were similar to those found in other studies of physicians' information needs[3,6,7]. Eight of the highest ranked questions were selected to test the adequacy of MEDLINE as a knowledge resource for decision making.

Residents in internal medicine were asked to choose one question from the list of eight and to answer it using WebMedline, a graphical interface to MEDLINE[8]. A medical librarian instructed each resident in the use of the program but provided no additional assistance with the search. The resident then performed the search under her silent observation. Only after the resident felt he or she had exhausted the search and could find no additional relevant citations, did the librarian intervene. In a second brief tutorial, the librarian explained the concept of medical subject headings (MeSH) and their hierarchical organization[9]. Then the librarian and resident worked together on WebMedline using combinations of MeSH terms and keywords to exhaust the search. Finally, they performed the search using a telnet-based, command-line version of MEDLINE.

From this informal study we made several observations. Most residents preferred the graphical interface to the command-line interface, but they were relatively unfamiliar with MeSH terms. Using MeSH terms and their qualifiers, the librarian's searches were generally felt to be more precise and relevant. Resident searches took from twenty-five to 105 minutes and were clearly too time-consuming for point-of-care decisions. Most importantly, the librarian found that some of the more difficult answers could be found using an online textbook or drug database. We concluded that online information systems require multiple, integrated resources to answer clinical questions effectively. Moreover, we feel that physicians can be taught to use a simple, graphical interface quickly and that if they have assisted access to a controlled vocabulary such as MeSH, they can perform efficient searches.

SHINE – INTEGRATED INFORMATION

With the belief that clinical decision making requires integrated information, we developed SHINE, a World Wide Web (WWW)-based system that provides high quality medical knowledge in an easily accessible format. We believe the SHINE paradigm for strategic decision support and in-depth education removes many of the traditional obstacles to medical knowledge acquisition. We also feel that physicians learn and retain most effectively when they research answers to questions in the context of managing a specific patient. The goal with SHINE is to let them answer these questions and receive credit for doing so.

Objectives

1. Integrate and deliver high quality medical knowledge and the expertise of academic professionals to community-based primary care physicians.

2. Refine the architecture and infrastructure of a knowledge delivery system that is easy to access and use.

3. Institute a new model for continuing medical education (CME) where credit is awarded for physician-initiated learning that occurs in the process of answering patient-specific questions.

4. Motivate physicians to use the information resource by demonstrating its ability to improve clinical decisions and patient care.

5. Improve health care delivery and medical education at the community level and beyond.

Knowledge Resources

The current SHINE prototype contains the following resources: a medical textbook – *Scientific American Medicine*, a pharmaceutical database – Micromedex, a comprehensive bibliographic database – MEDLINE, a medical differential diagnosis system – DXplain[10], the National Institute of Health Consensus

Statements, and the Agency for Health Care Policy and Research Clinical Practice Guidelines. In the near future, SHINE will also contain on-line medical journals for full-text retrieval (through Stanford Library's Highwire Press), an extensive instructional digital video database, and a dermatology image database. Furthermore, the developers have integrated a unique collection known as the Primary Care Teaching Modules (PCTMs). The PCTMs were created for teaching conferences in primary care clinics by Stanford medical faculty and house staff in collaboration with colleagues at the University of California, San Francisco.

Several additional texts to be incorporated include: *Cecil's Textbook of Internal Medicine*, *The Nelson Textbook of Pediatrics*, and *Dorland's Medical Dictionary*. As part of the SHINE evaluation plan, the information needs of physician-users will be routinely reassessed to assure currency of the content, as well as to provide additional resources when the need occurs.

Remote Medical Consultation

For answers that are not forthcoming from the above collection of resources, we are developing a tele-consultation system that will include real-time video conferencing with white-board capability and e-mail. The tele-consultation application will be based on currently available browser plug-ins and linked to a physician database. This application will first ask the user to select e-mail or a real-time consult, based on the urgency of the situation. We believe that the majority of tele-consultation needs can be met by relatively low bandwidth applications allowing us to maintain maximum access to medically and technologically underserved areas.

If the clinical problem requires more immediate advice, a live video conference can be initiated with a white-board to share pieces of data. Users will be prompted to select an available expert from the consultant database. Initially, these experts will be drawn from the Stanford system.

Continuing Medical Education

We propose a novel paradigm for CME. Since most physicians are motivated to learn when asking questions about specific patients, we plan to reward them for applying new knowledge in this context. By consulting information systems for help, physicians often imply a need for CME. We are testing several methods designed to assure that sessions with SHINE warrant CME credit. As physicians use SHINE to answer questions generated during patient encounters, a log will track their use of the various resources. If users desire credit for the session, they will be required to submit the question asked and the resources they used to answer it. Through an interactive Web interface, they will be asked to state what they learned from the session, how it impacts future decision making, and how long they spent answering the question. A CME review committee will evaluate these responses to guarantee that they reflect an understanding of the materials read and that they apply to the question answered. We are also developing a method that automates the CME evaluation to lessen the need for human intervention.

Resource Organization and Integration

The resources in SHINE are intuitively organized and can be simultaneously searched with a simple, integrated mechanism, while a sophisticated query interface is available for more advanced users. Context-sensitive result displays and other features assist users in retrieving relevant material. As one example, hyperlinks among textbook references, MEDLINE, and full-text journal articles allow natural and efficient access to related information. During each session, all documents visited and queries submitted are saved in an electronic log, and users are able to return to this information at any time. A component of the log is a notebook function which allows users to save important documents or queries indefinitely and permits them to designate agents that automatically retrieve information on any specified subject. All log and notebook information is stored centrally and is available to users from any computer on the network (e.g. in the clinic, on the ward, and at home).

SHINE Architecture

SHINE is structured as a client-server system overlaid on the WWW. The following functions are currently available to the user:

- query multiple content collections through a single formulation and view the results in a common interface
- restrict a query to a single collection
- browse a selected content collection

- retrieve information from multiple collections
- access specialized tools such as the medical diagnosis program, DXplain
- select and save retrieved information to the user's notebook
- open the notebook to review previously retrieved information

Functions being added include:

- refine a query through interaction with a thesaurus and a concept tree
- submit a search history from the log for CME credit
- consult with a network of medical experts and share data in a white-board environment by way of a remote tele-consultation system

Commands or requests, such as for query, browsing, or notebook functions, activate separate functional capabilities in the server. A standard programming interface has been developed for queries to multiple content collections. Query requests are converted to a format appropriate for access to the individual collection or database. Three interfaces have been implemented: Oracle SQL, WAIS full-text search, and Z39.50 bibliographic service. Information returned from these collections is formatted into an HTML document and transmitted back to the user for viewing and interaction. Each content collection also has its own query and browse interface, allowing access to special search capabilities that are not common to all collections. Special services, such as the diagnostic decision support system provided by DXplain are accessed through their native interfaces.

Since users prefer a single environment for all their information needs, it is likely that SHINE will be most useful if integrated with an electronic medical record. As the system matures, we plan to incorporate it into other medical applications.

CONCLUSION

We have built a working prototype that integrates multiple, heterogeneous medical knowledge resources with a simple interface on the WWW. An formal evaluation is planned to refine the system and to test its utility for improving clinical decisions.

Acknowledgments

The authors thank Edward H. Shortliffe, Larry Basso, Bill Wood, and Joseph Hopkins for their generous advice, support, and contribution.

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